Claims

I claim

1. A method for measuring the temperature of an object or environment with a photoluminescent probe, comprising the steps of:

a) providing a probe in thermal communication with said object or environment, said probe including a photoluminescent material so characterized that, when illuminated at any temperature within the temperatur range of application of the method with a first excitation light of intensity $\mathbf{P}_1$ and pre-selected wavelength or wavelengths λ_1, it emits a first luminescence light of intensity $\mathbf{I}_1$ and when illuminated with a second excitation light of intensity $\mathbf{P}_T$ and pre-selected wavelength or wavelengths λ_V, it emits a second luminescence light of intensity $\mathbf{I}_T$ so related to the luminescence intensity $\mathbf{I}_1$ that the ratio $(\mathbf{I}_T.\mathbf{P}_1/\mathbf{I}_1.\mathbf{P}_T)$ varies substantially in a known manner with varying temperature independently of any temperature-dependent changes in the luminescence efficiency of said photoluminescent material;

b) illuminating said material with said first excitation light of said wavelength or wavelengths λ_1 and intensity $\mathbf{P}_1$, thereby generating a first luminescence light emitted by the probe with said intensity $\mathbf{I}_1$;

c) directing a fraction of said intensity $\mathbf{I}_1$ of said first luminescence light to photodetector means;

d) illuminating said material, subsequently to its illumination with said first excitation light, with said second excitation light of an intensity $\mathbf{P}_T$ and wavelength or wavelengths λ_V, thereby generating a second luminescence light emitted by the probe having an intensity $\mathbf{I}_T$;

e) directing a fraction of said intensity $\mathbf{I}_T$ of said second luminescence light to photodetector means; and

f) measuring the relative intensities of the luminescence lights generated by said first and said second excitation lights received by said photodetector means, said relative intensities being an indicator of the temperature being measured.

2. A method as claimed in claim **1** wherein the ratio $(\mathbf{I}_T.\mathbf{P}_1/\mathbf{I}_1.\mathbf{P}_T)$ increases substantially in a known manner with increasing temperature;

3. A method as claimed in claim **1** wherein said probe is attached to the distal end of an optical fiber light guide having a proximal end and a terminal end; said first and second excitation lights are injected into the optical fiber light guide at or near its proximal end, and said fractions of the intensities of said first and said second luminescence lights are directed by said optical fiber light guide to said photodetector means, said photodetector means being located near the proximal end of said optical fiber light guide.

4. A method as claimed in claim **1** and adapted to measure oxygen pressure in addition to temperature, wherein said photoluminescent material is additionally so characterized that, when excited with said excitation light of wavelength or wavelengths λ_1 at any temperature within the useable temperature range of application of the method, it emits a luminescence light with a normalized intensity, relative to the intensity of the excitation light of wavelength or wavelengths λ_1, which decreases in a known manner with increasing oxygen pressure, the method additionally comprising the step of measuring said normalized luminescence intensity , said intensity being an indicator of said oxygen pressure at the measured temperature.

5. A method as claimed in claim **1** and adapted to measure oxygen pressure in addition to temperature, wherein said photoluminescent material is additionally so characterized that, when excited with said excitation light of wavelength or wavelengths λ_1 at any temperature within the useable temperature range of application of the method, it emits a luminescence light having a decay time τ which decreases in a known manner with increasing oxygen pressure, the method additionally comprising the steps of exciting said material with said pulsed or AC-modulated light and measuring said luminescence decay time, said decay time being an indicator of said oxygen pressure at the measured temperature.

6. A method as claimed in claim **4** wherein said probe is attached to the distal end of an optical fiber light guide having a proximal end and a terminal end; said excitation lights are injected into the optical fiber light guide at or near its proximal end, and said luminescence lights are directed by said optical fiber light guide to said photodetector means, said photodetector means being located near the proximal end of said optical fiber light guide.

7. A method as claimed in claim **4** wherein said photoluminescent material is comprised of a single luminophor.

8. An arrangement for measuring the temperature of an object or environment, comprising

a) a probe in thermal communication with said object or environment, said probe including a photoluminescent material so characterized that, when illuminated at any temperature within the temperature range of application of the arrangement with a first excitation light of intensity $\mathbf{P}_1$ and pre-selected wavelength or wavelengths λ_1, it emits a first luminescence light of intensity $\mathbf{I}_1$ and when illuminated with a second excitation light of intensity $\mathbf{P}_T$ and pre-selected wavelength or wavelengths λ_v, it emits a second luminescence light of intensity $\mathbf{I}_T$, the relative responses of the luminescence intensities $\mathbf{I}_T$ and $\mathbf{I}_1$ to a temperature change being such that the ratio $(\mathbf{I}_T.\mathbf{P}_1/\mathbf{I}_1.\mathbf{P}_T)$ varies substantially in a known manner with increasing temperature;

b) first light source means for illuminating said material with said first excitation light of said wavelength or wavelengths λ_1 and intensity $\mathbf{P}_1$, and thus generating a first luminescence light emitted by the probe with said intensity $\mathbf{I}_1$;

c) second light source means for illuminating said material with said second excitation light of an intensity $\mathbf{P}_T$ and wavelength or wavelengths λ_v, thereby generating a second luminescence light emitted by the probe having an intensity $\mathbf{I}_T$;

d) optical means for directing a fraction of said intensity $\mathbf{I}_1$ of said first luminescence light to photodetector means;

e) optical means for directing a fraction of said intensity $\mathbf{I}_T$ of said second luminescence light to photodetector means; and

f) photodetector and associated electronic means for measuring the relative intensities of the luminescence lights generated by said first and said second excitation lights received by said photodetector means, said relative intensities being an indicator of the temperature being measured.

9. An arrangement as claimed in claim **8** wherein said probe is attached to the distal end of an optical fiber

light guide having a proximal end and a terminal end; said first and said second excitation light source means are configured to inject said first and said second excitation lights into the optical fiber light guide at or near its proximal end; said optical fiber light guide is provided with optical pathways for directing fractions of the intensities of said first and said second luminescence lights to said photodetector means, said photodetector means being located near the proximal end of said optical fiber light guide.

10. An arrangement as claimed in claim **8** wherein said probe is a coating applied to the surface of said object or part thereof.

11. An arrangement as claimed in claim **8** and adapted to measure oxygen pressure in addition to temperature, wherein said photoluminescent material is additionally so characterized that, when excited with said excitation light of wavelength or wavelengths λ_1 at any temperature within the useable temperature range of application of the method, it emits a luminescence light with a normalized intensity, relative to the intensity of the excitation light of wavelength or wavelengths λ_1, which decreases in a known manner with increasing oxygen pressure, the arrangement additionally comprising means for measuring said normalized luminescence intensity, said intensity being an indicator of said oxygen pressure at the measured temperature.

12. An arrangement as claimed in claim **11** wherein said probe is attached to the distal end of an optical fiber light guide having a proximal end and a terminal end; said excitation lights are injected into the optical fiber light guide at or near its proximal end, and said luminescence lights are directed by said optical fiber light guide to photodetector means, said photodetector means being located near the proximal end of said optical fiber light guide.

13. An arrangement as claimed in claim **8** and adapted to measure oxygen pressure in addition to temperature, wherein said photoluminescent material is additionally so characterized that, when excited with a pulsed or AC-modulated light of wavelength or wavelengths λ_1 at any temperature within the useable temperature range of application of the arrangement, it emits a luminescence light with a decay time τ which decreases in a known manner with increasing oxygen pressure, the arrangement additionally comprising the light source means for exciting the luminescence of said material with said pulsed or AC-modulated light and for measuring said luminescence decay time, said decay time being an indicator of said oxygen pressure at the measured temperature.

14. An arrangement as claimed in claim **13** wherein said probe is attached to the distal end of an optical fiber light guide having a proximal end and a terminal end; said first and said second excitation light source means and said pulsed or AC-modulated light source means are configured to inject into the optical fiber light guide at or near its proximal end, and said luminescence lights are directed by said optical fiber light guide to said photodetector means, said photodetector means being located near the proximal end of said optical fiber light guide.

15. A method for measuring temperature with a photoluminescent probe, comprising the steps of:

a) providing a probe in thermal communication with said object or environment, said probe including a photoluminescent material so characterized that, when illuminated at any temperature within the temperature range of application of the method with a first excitation light of intensity $\mathbf{P}_1$ and wavelength or wavelengths λ_{v1}, it

emits a first luminescence light of intensity $\mathbf{I}_1$ and when illuminated with a second excitation light of intensity $\mathbf{P}_2$ and pre-selected wavelength or wavelengths λ_{v2}, it emits a second luminescence light of intensity $\mathbf{I}_T$ so related to the luminescence intensity $\mathbf{I}_1$ that the ratio $(\mathbf{I}_2.\mathbf{P}_1/\mathbf{I}_1.\mathbf{P}_2)$ varies substantially in a known manner with varying temperature independently of any temperature-dependent changes in the luminescence efficiency of said photoluminescent material, the wavelengths λ_{v1} and λ_{v2} being within the same chosen absorption and luminescence excitation band and so chosen that each of said excitation lights excites the luminescence of molecules or ions of said material occupying a thermally excited level, the energy level of the molecules or ions excited by light of wavelengths λ_{v1} being measurably different from the energy level of the molecules or ions excited by light of wavelengths λ_{v2};

b) illuminating said material with said first excitation light of said wavelength or wavelengths λ_{v1} and intensity $\mathbf{P}_1$, thereby generating a first luminescence light emitted by the probe with said intensity $\mathbf{I}_1$;

c) directing a fraction of said intensity $\mathbf{I}_1$ of said first luminescence light to photodetector means;

d) illuminating said material, subsequently to its illumination with said first excitation light, with said second excitation light of an intensity $\mathbf{P}_2$ and wavelength or wavelengths λ_{v2}, thereby generating a second luminescence light emitted by the probe having an intensity $\mathbf{I}_2$;

e) directing a fraction of said intensity I_T of said second luminescence light to photodetector means; and

f) measuring the relative intensities of the luminescence lights generated by said first and said second excitation lights received by said photodetector means, said relative intensities being an indicator of the temperature being measured.

16. A method as claimed in claim **16** and adapted to measure a second physical parameter in addition to temperature, said second physical parameter chosen from the group comprising an electrical current, a magnetic field and an electrical field or voltage.